PRIVATE PARTY COMMENT LETTERS

HUNTINGTON BEACH COASTAL COMMUNITIES ASSOCIATION
A community-based organization dedicated to the betterment of our coastal community and the families that live there.

November 4, 2002

RECEIVED
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City of Huntington Beach
2000 Main Street
Huntington Beach, California 92648

Attention: Ms. Mary Beth Broeren

Subject: Draft EIR for the Poseidon Seawater Desalination Plant, dated September, 2002.

Ladies and Gentlemen:

The following are our comments related to the aforementioned project.

We are certainly aware of the critical need Southern California has for new sources of fresh water, and that the supplies we have relied on for years, such as the Colorado River and the Eastern Sierras will be much more limited in the future. We are also aware that with the advancements of technology, desalination projects such as Poseidon will be becoming more popular. It also makes sense that Poseidon would have a special interest in piggybacking onto the AES facility because of their existing pipelines leading to and from the ocean. With the difficulty of getting a new water source like this approved today, this may be the biggest single component which makes this project potentially viable. a

With that said, HBCCA has a general concern that once again, the southeast portion of Huntington Beach will be having to deal with yet another industrial facility while getting no benefit from it. It is our understanding that at least to date, no agreement has been reached between the city and Poseidon on keeping at least a percentage of the water refined here to stay here. It appears that ALL the water Poseidon generates will be on its way to cities in the south county. Apparently they have a greater need for water than we do. Not to sound like a group of "NIMBY's", but we certainly get a familiar feeling that we have to deal the back-side of an industry meant to help everyone but us. Please do not under-estimate this concern. For HBCCA to line up in favor of this project, the city and Poseidon MUST come to an agreement on receiving at least a significant percentage of it's water. b

Other specific concerns are:

1. The DIER talks about higher salinity water being discharged back into the ocean. There is significant discussion about it in the DEIR by people who we can assume are very well educated and knowledgeable about the potential effects of this process. But it is our very un-educated belief that we have a very sick ocean here at times. The "experts" don't seem to agree on what the cause is of how to help it. With the OCSD facility down the road and with urban runoff problems, we are concerned that by adding one more problem to an already very complex issue, we may never have a truly healthy ocean. If the experts don't agree on solutions, how is it that this DEIR has determined anything conclusive? Maybe the DEIR is correct, maybe it's not. How can we be sure? How can we possibly afford to be wrong? c

2. The DEIR talks about one (1) 10,000 gallon ammonia tank which would be located on site. Since this facility is very close to residences and schools, we are concerned that in the unlikely event of a catastrophic failure of that tank, thousands of people would be affected. We suggest the use of two (2) or even three (3) tanks instead, thus reducing the volume affected by that kind of failure. (Please note a discrepancy in the DEIR regarding the tank's volume where on page 3-10 it states 1,000 gallons and on page 4.8-7 it states 10,000 gallons.) d

3. We would assume the term "non-rated" for the Chemical Storage Building, Bulk Chemical Building and Electrical/Substation Building does not mean they will not include full fire sprinkler systems, fire annunciation systems and be built to all applicable building codes. e

4. HBCCA obviously favors the option of placing the main storage tank below grade in lieu of on grade. f

While HBCCA is not opposed to Poseidon, per se, we do find these items as significant problems that do need to be addressed. Unfortunately, we do not have any solutions to our biggest concern. While the experts debate what the causes and affects of the beach closures are, we can only hope that measures already made and measures in the future will help. We don't see any way of knowing if Poseidon will make it worse. And that alone makes it worse. g

Please feel free to contact us with any questions.

Very truly yours,

HBCCA

David Guido
President
21241 Lochlea Lane
Huntington Beach, CA 92646
714-536-8695
e-mail: hbcca2000@yahoo.com

cc: Mr. Andy Shea, Poseidon
Mr. Ed DeMeulle, SEHBNA

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Response No. 18

Huntington Beach Coastal Communities Association
David Guido, President

18a. This introductory paragraph to the letter does not require a response.

18b. Comment noted. No water distribution agreements have been reached. Such agreements will occur during later phases of the project. It is unknown at this time whether or not the City of Huntington Beach will negotiate to receive an entitlement to product water from the proposed project.

18c. Modeling for proposed marine water quality effects of the proposed project was based on the best available information: empirical data (previous surveys/analyses of marine biology) and computer modeling. Although not anticipated to be a significant impact, the primary concern regarding the water quality issue is salinity. The project would not alter the operation of the OCSD facility or contribute to urban runoff.

18d. Section 4.8, *HAZARDS AND HAZARDOUS MATERIALS*, of the Draft EIR has been corrected to show that only a 1,000 gallon ammonia tank (**not** a 10,000 gallon tank) will be situated on-site. As stated in the Draft EIR, this tank would be equipped with a 110-percent spill containment structure, and numerous leak and spill containment measures would be implemented to minimize risk of upset. In addition, the existing fuel oil containment berms along the northern and eastern boundaries of the site would remain in place and would provide an additional level of protection should a hazardous material spill occur. Given the spill containment features to be incorporated into tank design along with the existing on-site berms, it is not anticipated that multiple ammonia storage tanks would be necessary.

18e. An explanation for the term "Type-II, non-rated" has been incorporated into Section 3.0, *PROJECT DESCRIPTION,* of the Draft EIR, and is shown in Section 3.0, *ERRATA.* It should be noted that all proposed structures will be required to comply with state and local standards in regards to fire and structural safety.

18f. Comment noted.

18g. This paragraph provides a conclusion to the comment letter and does not require a response.

COMMENT 19

Ramos, Ricky

From: Broeren, Mary Beth
Sent: Monday, November 04, 2002 4:57 PM
To: Ramos, Ricky
Subject: FW: Poseidon EIR Comment

-----Original Message-----
From: edkerins@netscape.net [mailto:edkerins@netscape.net]
Sent: Monday, November 04, 2002 3:39 PM
To: mbroeren@surfcity-hb.org
Subject: Poseidon EIR Comment

What will be required for the desalination plant to operate if the AES plant is closed down for any purpose?] a

What are the environmental and operational impacts of these requirements?] b

Edward Kerins

Response No. 19

Ed Kerins

19a. The proposed desalination facility will utilize the intake/outfall structures and pumps to circulate a total of 126 mgd. These pumps will operate constantly and will be independent of the AES Generating Station. Should the AES facility cease to operate, the proposed desalination facility will continue to produce and distribute potable water. This information has been added to Section 3.0, *PROJECT DESCRIPTION*, of the Draft EIR and is shown in Section 3.0, *ERRATA.*

19b. As state previously, the proposed desalination plant would remain operational constantly and independently of the AES Generating Station. No environmental impacts are anticipated should the AES Generating Station be shut down, as the 126 million gallon per day pumps are existing and no construction of additional facilities for this purpose beyond that already proposed would be necessary.

COMMENT 20

GEORGE E. AND CHARLOTTE A. MASON
21641 Bahama Lane, Huntington Beach, CA 92646-7809
Phone: (714) 964-1457 E-Mail: gemason@att.net

November 27, 2002

Mr. Ricky Ramos
City of Huntington Beach
Planning Department
2000 Main Street
Huntington Beach, CA 92648

Re: Draft EIR No. 00-02; Poseidon Seawater Desalination Plant

Dear Mr. Ramos:

The following comments apply to the referenced EIR.

1. Several sections of the EIR (Section 3.0 page 3-14, Section 4.8, etc.) discuss both a primary and an alternate method of disposing of the first flush of the reverse osmosis (RO) membrane concentrate waste cleaning solution. In both methods of disposal, the first flush is directed to the "washwater tank" where it is treated. In the primary method of disposal, the washwater tank is discharged to OCSD's sanitary sewer for treatment and then dispersed in 195 feet of water over four miles at sea off the Santa Ana River. In the alternate method, the contents of the washwater tank are pumped through the AES cooling water discharge line to upwell in 30 feet of water about 1500 feet off the beach at Newland and PCH. The alternative method of washwater disposal should not be allowed and the primary method should be the only acceptable method of disposal. **All scenarios for dumping of contaminated RO train washwater through the AES cooling water discharge line are unacceptable and this method of disposal of washwater must not be allowed.** There is a potential for buildup of hazardous chemicals near the discharge point and the discharge adds to an already heavy burden of actual and perceived pollution problems for the beaches near the AES generating station. Additional reasons for tourists and residents NOT to use our beaches is neither wanted nor needed. **DO NOT AGREE to the alternate method of direct ocean disposal of the first flush of RO train chemical cleaning solution and the hazardous contents of the washwater tank. Require disposal of all first flush remains to OCSD's sanitary sewer system.**

2. Noise is a major factor of concern to the residents in the area of the proposed desalination plant. Electric pumps and energy recovery turbines are noisy and operate at multiple frequencies. Extra care must be taken to prevent disruption of the nearby residential areas due to high, medium and/or low pitched sounds emanating from the facility. ALL pumps should be enclosed indoors (the EIR mentions that some pumps will be outside) and provided with acoustic treatment. The EIR states (on page 4.5-9), "The increase in noise levels from stationary sources associated with the project is not anticipated to result in a noticeable increase in the ambient noise level and is therefore considered to have a less than significant noise impact." **Noise has such a significant potential impact on neighboring residences (and on future residences such as development of the Ascon/Nesi hazardous waste site very near the project site) that a significant bond should be required to insure the project meets or exceeds the City of**

Huntington Beach Municipal Code (Chapters 8.40.050) requirements for a residential "noise zone." Section 8.40.040 of the Huntington Beach Municipal Code designates four noise zones (numbered 1 through 4), namely residential, professional/public, commercial, and industrial. While the desalination plant is clearly in an industrial noise zone, Zone 4, the Municipal Code Section 8.40.050 sound pressure level limits of 55 dbA daytime and 50 dbA nighttime referenced on page 4.5-8 of the EIR are for a residential noise zone, Zone 1. The industrial noise zone sound pressure level limit for noise zone 4 in Section 8.40.050 of the Municipal Code is clearly stated as "70 db(A) - Anytime." Because of this difference, the developer needs to make it clear that it is intended that the project will meet a lower noise limit for this project. **A contractually binding document needs to be developed between the City and the developer agreeing that noise levels will not exceed those shown in the Huntington Beach Municipal Code for a residential noise zone (Zone 1 in Section 4.40.050) and accepting the reduction in permissible noise in an industrial zone as a condition for approval of a permit to build.** Failure to execute such a binding agreement will undoubtedly eventually result in an increase in noise in the area to that permitted in an industrial zone for the desalination plant and will be severely detrimental to the area's residents. This industrial facility is very close to many hundreds of residential units and must not be allowed to generate a noticeable increase in ambient noise at any time. b

Sincerely,

George E. Mason

Charlotte A. Mason

Response No. 20

George E. and Charlotte Mason

20a. The method of disposal for washwater associated with RO membrane maintenance will be determined during the design phase of the proposed project. However, under either scenario (disposal through Orange County Sanitation District [OCSD] facilities or discharge through the AES outfall), the washwater discharge will comply with all applicable marine water quality standards. The option to utilize the AES outfall to discharge the washwater will be evaluated in close coordination with the Regional Water Quality Control Board (RWQCB) and its National Pollution Discharge Elimination System (NPDES) permit requirements. This comment will be considered during the approval and subsequent regulatory permitting process for the proposed project.

20b. As stated within Section 4.5, *NOISE*, of the Draft EIR, the proposed project will comply with the City's Municipal Code (Chapters 8.40.050 and 8.40.070) requiring that noise levels at the property boundary should not exceed 55 dBA between the hours of 7:00 am and 10:00 pm, and 50 dBA between the hours of 10:00 pm and 7:00 am. Interior noise levels will not exceed 55 dBA between the hours of 7:00 am and 10:00 pm, and 45 dBA between the hours of 10:00 pm and 7:00 am. Prior to the issuance of any building or grading permits, a construction-level acoustical analysis report and appropriate plans will be prepared to ensure that the City's noise standards are not exceeded. As such, a contractually binding document between the applicant and City is not anticipated to be necessary.

COMMENT 21

NOV 04 2002

VPC *VARI-POWER COMPANY*

582 Rancho Santa Fe Rd., Encinitas, CA 92024 TEL: 760-753-1984 FAX : 760-753-2453

E-mail: eChilds@sdcoe.k12.ca.us

EFFICIENT ENERGY CONVERSION

October 31, 2002

TO: Ricky Ramos
Planning Department
City of Huntington Beach
2000 Main Street,
Huntington Beach, CA 92648

714-536-5264

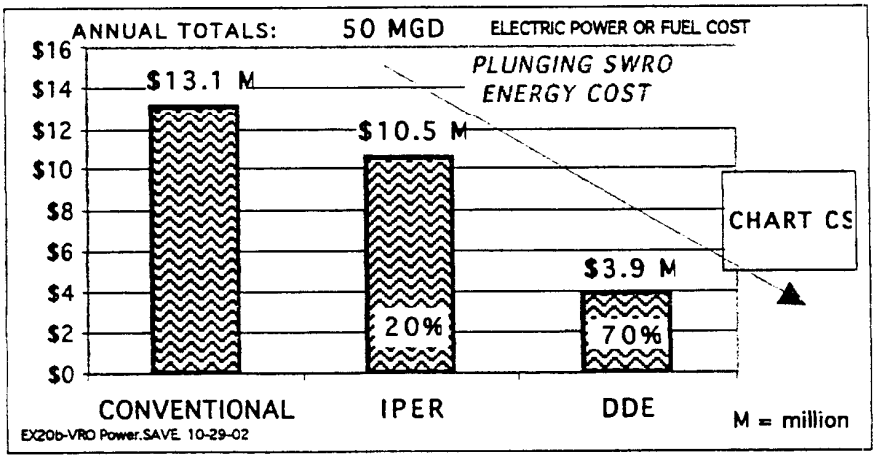
FROM: Willard Childs

SUBJECT: Draft EIR #2001051092, Poseidon Seawater Desalination Project, September 19, 2002. Written comments due by November 4, 2002.

REFERENCE: Section 4.6 PUBLIC SERVICE AND UTILITIES, Page 4.6-19, Electricity.

Thank you for the opportunity to comment on the Draft Environmental Impact Report for this very important project. It is well known that Southern California faces severe water shortages, and it only makes sense to look to the Pacific Ocean to augment natural supplies. The purpose of this Draft EIR comment memo is to introduce you to innovative methods (known as the VARI-RO technologies), which can reduce the cost of seawater desalination. To assure that these needed technologies are available in time to be used in your facility, it is suggested that the City of Huntington Beach take a leadership role to proceed with the demonstration project mentioned below.

PRESENTLY, ELECTRIC POWER COST LIMITS SEAWATER DESALINATION USE: In the past, high energy cost has been the primary limitation for the use of seawater desalination. Even though there have been substantial improvements over the past 10 years, this is still a significant consideration. This high energy cost relates to the installed electric power base (or availability from remote locations), the actual cost of using this power, and the resulting emissions (whether in the local air basin or remote locations). The VARI-RO technologies offer a solution to these problems; and have been studied, tested, and evaluated under a cost-share program sponsored by the U. S. Bureau of Reclamation (USBR). CHART CS indicates the potential savings that can be realized with the IPER (rhymes with viper) and DDE versions — in million dollars ($xx.x M) per year.



DEMONSTRATION PROJECT & BENEFITS: These comments relate to the need to rapidly proceed with the VARI-RO technologies demonstration project — jointly funded by public and private organizations. The goal of this demonstration would be to show that the electric power requirements, and cost, can be dramatically reduced as compared to presently available methods. By proceeding with this demonstration, the public stands to obtain the greatest benefit — because of the energy cost savings that can be realized. The project developers, and others, would also gain benefits from these very substantial energy cost savings.

INNOVATIVE TECHNOLOGIES TO HELP SOLVE THE PROBLEM: During and after the previous six year California drought, we recognized the need for reducing the energy cost for seawater reverse osmosis (SWRO) desalination. This resulted in innovative energy conversion approaches, known as the VARI-RO technologies. The subsequent effort resulted in two studies and two pilot plant projects, which were cost-share funded by USBR — and a broad coalition of public and private organizations. These four USBR reports, Nos. 4, 30, 33, and 62, are available for review on this web site: http://www.usbr.gov/water/content/c_reports.html. The need for a demonstration project is stated on Pages 37 and 36 of USBR Reports No. 30 and 62, respectively. The technologies are briefly described in the enclosed technical paper.

ENERGY COST SAVINGS: It has been shown that with the **IPER (Integrated Pumping & Energy Recovery)** version, the electric power requirements to provide high quality desalted seawater will be less than pumping water from Northern California over the Tehachapi Mountains. For this comparison to the State Water Project, see the results in Report No. 62, May 2001, Page 35 — and the prediction in Report No. 4, June 1995, Page 24.

Furthermore, by using the **DDE (Direct Drive Engine)** version, natural gas can be used directly to power the desalination system, thus cutting out "middleman" losses, and costs, for electric power generation — plus use a lower cost energy source. The projected cost savings for a 25 MGD (million gallons per day) facility are given on Page 30 of USBR Report No. 62 — about 20% for the IPER version and about 70% for the DDE version.

ELECTRIC POWER COST SAVINGS FOR THE HUNTINGTON BEACH FACILITY: In Section 4.6, Page 4.6-19, it is projected that the power consumption for the facility will be 15 kwh/1000 gallons of fresh water produced. Using the following equation, the input electric power requirement (megawatts electric) can be estimated:

MWe = (MGD x (kwh/kgal)) ÷ 24 hours per day = 50 x 15 / 24 = 31.25 megawatts for the facility.

For this facility, the major energy consumption is from the high-pressure pumping and energy recovery system for the SWRO membranes, which forces the fresh water through the fine pores in the membrane. The remaining energy consumption is for the balance of plant. If we assume that the balance of plant requires 3 kwh/kgal, then the SWRO pumping would be 12 kwh/kgal.

MWe = 50 x 12 / 24 = 25 megawatts for the high-pressure pumping and energy recovery system.

The electric power cost can then be estimated from this equation:

$M/yr = (MWe x 24 hours per day x 365 days per year x $/kwh electric power cost) ÷ 1000

or in this case at an average electric power rate of 6¢ per kilowatt hour:

$M/yr = 25 x 24 x 365 x 0.06 / 1000 = $13.1 million per year for the conventional method.

IPER VERSION SAVINGS: It was projected that the IPER version could reduce the electric power requirements by 20% as compared to the conventional method. This would be a saving of $2.6 million per year, or about $79 million over the 30 year financing period for the facility.

DDE VERSION SAVINGS: It was projected the energy cost savings, using the DDE (natural gas fueled) version, would be about 70% based on natural gas cost of $3 / mmBTU (million British Thermal Units). This would provide an energy cost saving of $9.2 million per year, or about $275 million (in the range of 1/4 billion dollars) over the 30-year financing period.

ENCLOSURE: Technical Paper presented at the American Membrane Technology Association (AMTA), Tampa, August 6-9, 2002, ***"Low Energy Cost Seawater Desalting With VARI-RO Integrated Pumping & Energy Recovery"***, File: W15d-AMTA Cover 6-7-02.doc.

LOW ENERGY COST SEAWATER DESALTING WITH VARI-RO INTEGRATED PUMPING & ENERGY RECOVERY

This Technical Paper was presented at the following conference. and is in the conference CD under this file name: Poster_Childs.pdf.

American Membrane Technology Association (AMTA)
Water Quality Enhancement Through Membrane Technology
Tampa, Florida, August 6-9, 2002

http://www.membranes-amta.org/media/pdf/brochurewebsite.pdf
Session #2B, Energy Recovery Systems, Wednesday, August 7, 4-6 PM

Contact: Willard D. Childs, Vari-Power Company (VPC), 582 Rancho Santa Fe Rd., Encinitas, CA, TEL: 760-753-1984, FAX: 760-753-2453, CELL: 760-419-2554, eChilds@sdcoe.k12.ca.us

LOW ENERGY COST SEAWATER DESALTING WITH VARI-RO INTEGRATED PUMPING & ENERGY RECOVERY

Mr. Willard D. Childs, Vari-Power Company, Encinitas, CA

1. Introduction

Testing, evaluation, and analysis of the VARI-RO technologies (patents issued and pending) were accomplished under water treatment advancement programs sponsored by the U. S. Bureau of Reclamation (USBR) **[Ref. 1, 2, 3, 4]**. These four projects have shown that "low energy cost" seawater desalting can now be achieved for large-scale facilities using a highly-efficient, positive-displacement pumping and energy recovery system. This is uniquely accomplished without the pulsations and hydraulic shock previously associated with positive displacement methods.

While the focus of this technology development has been toward large-scale seawater reverse osmosis (SWRO) desalination, it can also provide similar benefits for low to medium capacity SWRO, brackish water reverse osmosis (BWRO) desalination, and wastewater recycling. The resulting energy cost reduction will help these water sources to be cost-effectively used worldwide for potable water, irrigation, and other purposes.

Versions and options of the technologies include:

VRO-IPER	Integrated Pumping & Energy Recovery (electric powered) version
VRO-ISB	Inter-Stage Boost option for the VRO-IPER version.
VRO-ER	Energy Recovery version.
VRO-DDE	Direct Drive Engine (fuel powered) version—for powering the VRO-IPER.
VRO-SOLAR	Solar Powered Desalting option—for VRO-IPER or VRO-DDE versions.

With the VR0-IPER[1] version, energy cost savings up to 40% can be provided for low to medium capacity trains, and 20% for high capacity trains, as compared to conventional methods using centrifugal pumps, energy recovery turbines, and variable frequency drives. With the VRO-DDE version, the technical evaluation accomplished during the USBR projects has shown that energy cost savings up to 70% can be achieved. The additional savings provided by the VRO-DDE version results from directly, and cleanly, using lower cost fuel as the energy source, instead of expensive electric power.

In addition to being highly efficient, a key feature of the novel VARI-RO approach is the high reliability, longevity, and low maintenance that can be achieved. These are accomplished as a result of low cycle speeds. At 15 CPM (cycles per minute) it would take 20 years to equal the number of cycles a 300 RPM plunger pump would get in one year. At 15 CPM it would take 100 years to equal the number of cycles a 1500 RPM diesel engine would get in one year.

> The "heart" of the VARI-RO system is the hydraulic drive—which has revolutionized the construction and earth moving industries over the last 25 years, and can now revolutionize the desalting industry.

This revolutionary approach is accomplished with commercially available equipment that has been previously proven in a wide variety of applications.

[1] The VRO-IPER (rhymes with viper) version was previously called the VRO-EMD (electric motor drive) version in some of the USBR reports.

2. Business Opportunity

We are seeking public and private participants, strategic partners, licensees, and investors for demonstration, business development, and commercialization of these needed technologies. A major business opportunity is emerging for the revolutionary VARI-RO™ "Low Energy" technologies for seawater reverse osmosis (SWRO) desalting.

WATER WILL BE THE MOST IMPORTANT RESOURCE OF THIS CENTURY:
Water availability and security is now a critical priority for the world. Fresh water is no longer an infinitely renewable resource; unlike oil, fresh water has no viable substitute. As the demand for increased water supplies continues to grow dramatically, desalination is the only realistic solution to provide new water resources worldwide. (Ref: IDA World Conference announcement, "Financing of Desalination Projects", London, May 9 & 10, 2002.

3. What problem does the VARI-RO™ technologies solve?

Currently high-energy consumption — resulting in high-cost — severely limits the use of seawater desalination to augment water supply shortages in many regions of the world. This is especially critical in regions that do not have adequate electric power supplies. For example, for the 50 MGD facility being planned for San Diego, the high cost (and availability) of electric power is one of the main concerns—as expressed by Board of Director members during public hearings.

As shown in **FIGURE 1** for 250 MGD (million gallons per day) capacity, with the VRO-DDE version the energy cost nearly becomes a "non-issue" (less than 1/3 the energy cost) as compared to conventional SWRO methods—using centrifugal pumps, Pelton wheel energy recovery, and variable frequency drives.

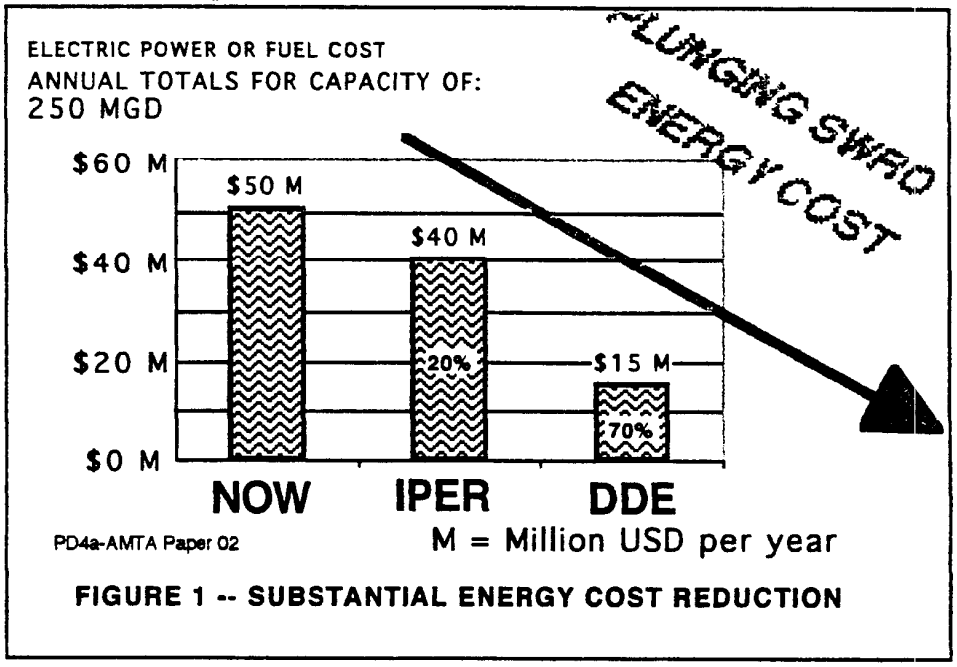


FIGURE 1 -- SUBSTANTIAL ENERGY COST REDUCTION

The VARI-RO™ technologies provide a significant advancement for seawater reverse osmosis (SWRO) desalination, including substantial energy cost savings and other operational benefits. These benefits will be accomplished by providing high-quality modular products that have efficiency,

installation, and operational benefits — as compared to current methods. Implementation of these advancements will help to assure that the planned seawater desalination projects go forward in the USA, and elsewhere around the world.

When this paper was being written, in the USA alone, over 250 MGD of SWRO capacity was being implemented, planned, or studied for California, Florida, and Texas. This is 10 times the capacity of the 25 MGD facility now being built for Tampa Bay Water (utility)—to be operational in early 2003.

4. Pilot Plant Testing and Evaluation

With cost-share funding provided by USBR and a broad coalition of public and private organizations, two studies and two pilot plant projects were conducted, as follows:

[Ref. 1] The first study, completed in June 1995, showed that the VARI-RO IPER version could provide substantial energy cost savings for the 30 MGD SWRO desalination facility that was under consideration for the San Diego region. Also, in this study, it was shown that seawater could now be desalted with less energy than pumping water from Northern California over the Tehachapi Mountains to Los Angeles and San Diego.

The relative power requirements (megawatts) for delivering 30 MGD of potable water to San Diego were given on Page 24 of this report (including ancillary power). These power requirements were:

CP-ERT	19.8 MW (SWRO using centrifugal pumps with energy recovery turbines)
SWP	18.8 MW (pumping from Northern California via the State Water Project)
VRO-IPER	14.6 MW (SWRO using the VARI-RO electric powered system)

The specific energy consumption calculated for the SWRO high pressure pumping, at 45% recovery ratio (RR), were 13.8 kwh/kgal for CP-ERT, and 9.7 kwh/kgal for VRO-IPER. The VRO-IPER system provided a saving of 30%, as shown in FIGURE 5.3 on Page 23 of this report.

[Ref. 2] For the first pilot plant project, completed in May 1998, a VARI-RO IPER version was designed, built, and tested under simulated SWRO system conditions at San Diego City's San Pasqual Water Reclamation Facility. To verify performance, a representative from the Navy's Seawater Desalination Laboratory, Port Hueneme, conducted the test runs. This representative verified the accuracy of the instrumentation. The test runs were made at the BENCH MARK test conditions of 800 psi (55 bar) membrane pressure, 40 psi membrane pressure drop, 12 CPM, and 43% RR. The product water flow rate was 43,500 GPD (gallons per day) {165 m^3/d}, and the specific energy consumption was 9 kwh/kgal (2.38 kwh/m^3) as shown on Page 25.

For higher capacity commercial units of 0.6 MGD (2271 m^3/d) capacity, it was projected that the energy consumption would reduce to 7.72 kwh/kgal (2.04 kwh/m^3) at 800 psi as shown on Page 29. The "base case" used for the comparative economic analysis was the 7.2 MGD (27.200 m^3/d) Santa Barbara Seawater Desalination facility built by Ionics as a result of water shortages created by the California six year drought. This facility had 12 trains of 0.6 MGD each, and the actual energy consumption reported by Ionics was 12.7 kwh/kgal (3.36 kwh/m^3) at 865 psi and 45% RR. Each train used the centrifugal pump, Pelton wheel energy recovery turbine, and variable frequency drive (CP-PW-VFD) method. The projected energy consumption for the VARI-RO Commercial unit was 8.27 kwh/kgal (2.2 kwh/m^3), providing a 35% savings—at 865 psi. This comparison is summarized on Page 30.

At an electric rate of $0.06/kwh, the annual energy cost savings was $646,000 per year or over $6 million for a 10 year period, as summarized on Page 35.

[Ref. 3] The second study, completed in September 1998, showed that the VARI-RO Direct Drive Engine (VRO-DDE) version could provide dramatically lower energy cost savings when used to power the VRO-IPER version. These lower energy cost savings would be accomplished by using a lower cost energy source, being more efficient, and cutting out "middleman" energy conversion losses. During this project, extensive analytical calculations and verification of theoretical performance were made by experts in the field, including: Dr. Helmut Weber, Flow Energy Engineering (FEE); Dr. Ali Dabiri, Science Applications International Corporation (SAIC); and Dr. Farrokh Issacci, AlliedSignal Corporation, Aerospace Equipment Systems (AES). AES is now known as Honeywell Environmental Systems.

This investigation proved that the VRO-DDE version was a technically sound approach, would dramatically lower the energy cost for SWRO desalination, and was practical. The following is an overview statement from the report, Page 7.

> "The VARI-RO Direct Drive Engine (VRO-DDE) system is a highly efficient, positive displacement, external combustion, thermal energy conversion method using the closed loop recuperated Brayton cycle. The Brayton thermodynamic cycle is the same cycle that is used with gas turbines and jet engines. These are continuous burn, external combustion, engine systems which have low emissions as compared to conventional internal combustion diesel or natural gas engines."

[Ref. 4] For the second pilot plant project, completed in May 2001, a VRO-DDE version proof-of-function unit was designed, built, and added to the VRO-IPER unit that was previously tested **[Ref. 2]**. This system was functionally tested at American Tool & Engineering's manufacturing facility, San Diego California. The features and benefits of the VRO-IPER and VRO-DDE systems are described on Pages 6 and 9, respectively; which are summarized as follows:

> The VARI-RO Integrated Pumping & Energy Recovery (VRO-IPER) system is highly efficient, and is adaptive to the variable conditions of seawater and brackish water reverse osmosis (SWRO & BWRO) desalination facilities. This unique system utilizes modern hydraulic power transmission and electronic control to provide the functions listed below:
> - Feed water pumping.
> - Concentrate energy recovery.
> - Variable flow and pressure for RO membrane optimization, startup, and shutdown.

The VARI-RO Direct Drive engine (VRO-DDE) system is a highly efficient, positive displacement, external combustion, heat engine. This engine will also provide low emissions as compared to conventional internal combustion diesel or natural gas engines. This is accomplished by using clean burning continuous combustion, as compared to the intermittent combustion of internal combustion engines. In addition, this engine system can use renewable thermal energy sources, such as solar and geothermal.

This unique system utilizes modern hydraulic power transmission and electronic control to provide the functions listed below:

- Direct acting reciprocating power output for the VRO-IPER system.
- Variable stroking speed and force for pumping optimization, startup, and shutdown.

In this report, energy cost savings (Page 30) were projected for a 25 MGD SWRO facility operating at 900 psi membrane pressure and 50% recovery ratio (RR). This cost comparison was based on \$0.06/kwh electric power rates, and \$3/million BTU natural gas rates. These savings were projected against a centrifugal pump, Pelton wheel, variable frequency drive, and sump pump (CP-PW-VFD-SP) system, as follows:

Type of System M = million	Annual Energy Cost	Annual Energy Savings	Percent Savings
CP-PW-VFD-SP	\$5.037 M		
VRO-IPER-EM Version	\$4.030 M	\$1.007 M	20%
VRO-DDE-SCL Version	\$1.451 M	\$3.586 M	71%

EX92a-TWC IPER.DDE. 1-26-01 Case C-1

Savings with the VRO-IPER version were \$1 million per year (20%), and with the VRO-DDE version \$3.5 million per year.

The continued development recommendations (Page 36) for the VRO-IPER and VRO-DDE systems were as follows:

9.2 Demonstration of Full-scale Capacity Unit.

It is recommended that a demonstration project be implemented to design, manufacture, and test a full-scale unit in the 200,000 to 600,000 GPD (757 to 2,270 m^3/d) capacity range. The objectives for this project include the following:

- Show that the efficiency projections for a Full-scale Commercial capacity unit can be achieved.
- Demonstrate to the desalting industry that the technology is viable and should be considered as a preferred method for future desalting plants, and as a retrofit for existing facilities.
- Put the VARI-RO system side-by-side with a conventional system to show the installation, operational, and energy saving features of the technology.

5. Economic Benefits

VRO-IPER VERSION ELECTRIC POWER SAVINGS: It has been projected that the VRO-IPER version would save 20% as compared to conventional methods using centrifugal pumps and Pelton wheel energy recovery turbines—for large-scale facilities. For 250 MGD capacity, the electric power plant capacity needed could be reduced from about 100 to 80 MW (megawatt), providing a 20 MW savings.

With conventional methods, the estimated electric power cost (see **FIGURE 1**) would be about $50 million per year at $0.06 per kilowatt-hour — resulting in a total power cost of over $1.5 billion over the 30 year financing period for these facilities. An electric power cost saving of 20% would reduce the cost of electricity by $10 million per year, or about $1/3 billion over 30 years.

VRO-DDE VERSION ELECTRIC POWER SAVINGS: Another alternative for the 250 MGD capacity would be to directly use natural gas (or other fuel), instead of expensive electric power, using the VRO-DDE (fuel powered) version. For example, by using natural gas directly as the energy source, then 100 MW of electric power generation capacity would not be needed. This could be an important consideration for major SWRO facilities in regions like California that have a shortage of electric power capacity, especially in the summer months (air conditioning load). The summer months are at the same time that additional water supplies are needed (especially during drought conditions). In addition, there would be additional capital cost savings for electric power transmission lines, sub-stations, transformers, and intra-plant electrical equipment—which would not be needed for the desalting facility.

A VARI-RO DDE version, using natural gas instead of electric power, is projected to provide a 70% energy cost saving—reducing the energy cost to $15 million per year. This is based on a fuel cost of $3 per million BTU. This would provide cost savings of over $1 billion—over the 30 year financing period for the 250 MGD of facility capacity.

6. Product Description — VRO-IPER Version

The **technological innovation** (patents issued and pending) of the VARI-RO Integrated Pumping & Energy Recovery (VRO-IPER) version results in a substantial electric power reduction for seawater reverse osmosis (SWRO) desalination, as compared to the CP-PW-VFD-SP method **[Ref. 3, Page 30]**. This is accomplished with positive-displacement, pressure-to-pressure, energy transfer methods—providing highly efficient energy conversion. This higher efficiency improves the economics of the seawater reverse osmosis (SWRO) desalination process.

The testing and evaluation sponsored by USBR **[Ref. 4, Pages 27 & 30]** has shown that 20 to 40% energy cost savings for SWRO desalination is achievable, as compared to the predominant methods now in use today for SWRO.

The VRO-IPER energy savings are accomplished with a highly efficient energy transfer method (reject concentrate directly to feed water pumping), with the additional energy boost coming from the unique hydraulic drive. The efficiency improvement is a result of direct, in-line, transmission of forces, as shown in **FIGURE 2**, without throttling of either the feed or the concentrate flow streams. In this figure, supply water from the ocean is pressurized in Chamber "A" to a pressure of about 1000 PSI (pounds per square inch). This provides feed flow to the RO membranes, resulting in about 50% of the supply becoming fresh product water and 50% becoming the reject concentrate at about 950 PSI. The high-pressure concentrate directly enters into Chamber "B" through energy recovery valves, and directly

applies about 50% of the force necessary to pump the feed water from Chamber "A". The remaining force to move the pumping piston is supplied by the hydraulic cylinder, which receives flow from a variable flow, reversible, hydraulic pump. The hydraulic drive consists of combining the hydraulic cylinder and pump.

The VRO-IPER innovation is made possible by the novel application of modern hydraulic power and computer control. The computer synchronizes the velocity of three hydraulic cylinders to provide smooth output flow, and properly times the energy recovery valves to eliminate hydraulic shock that is prevalent in the conventional work exchanger energy recovery (WEER) methods. The elimination of hydraulic shock is achieved by bringing the flow velocity to zero, before the energy recovery valves are opened or closed.

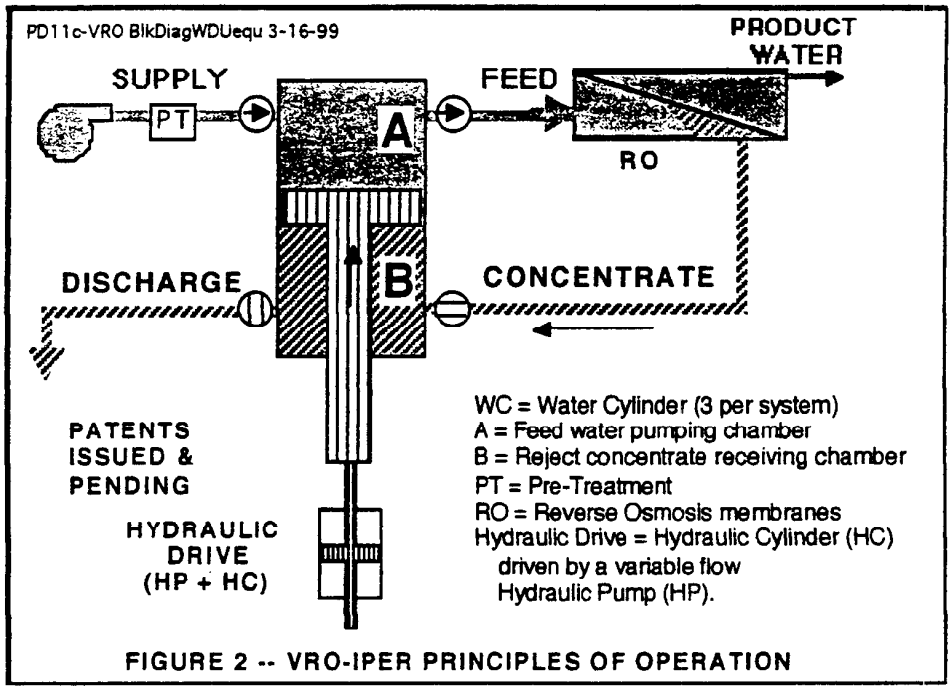


FIGURE 2 -- VRO-IPER PRINCIPLES OF OPERATION

For comparison, the key limitations of centrifugal pumps are low efficiency, and the inability to compensate for variable SWRO membrane pressures without using flow throttle valves or variable frequency drives to control pump speed. The key limitations of conventional positive-displacement pumps (triplex and quintuplex plunger) are the crankshafts, which must be driven at high speeds to keep the size and forces reasonable, and the plunger velocity is limited to sinusoidal motion. The sinusoidal plunger motion results in uneven flow output, which causes pressure pulsations. However, in spite of these limitations, positive-displacement pumps are more efficient, and adaptive, under variable pressure conditions than centrifugal pumps and energy recovery turbines. As a result, plunger pumps are often used when lower energy consumption is needed for SWRO desalination.

The innovative use of hydraulic power and computer control results in having the best of all worlds: smooth flow like centrifugal pumps, high efficiency and pressure adaptability of positive displacement pumps, low cycle speeds, and the high efficiency of the WEER system without hydraulic shock.

To supply smooth, non-pulsating flow to the RO membranes, a set of three hydraulic pump units rotate together on a common shaft. These variable-flow, variable-pressure units pump hydraulic fluid to the hydraulic cylinders—driving these up and down in a complementary fashion, as shown in **FIGURE 3**.

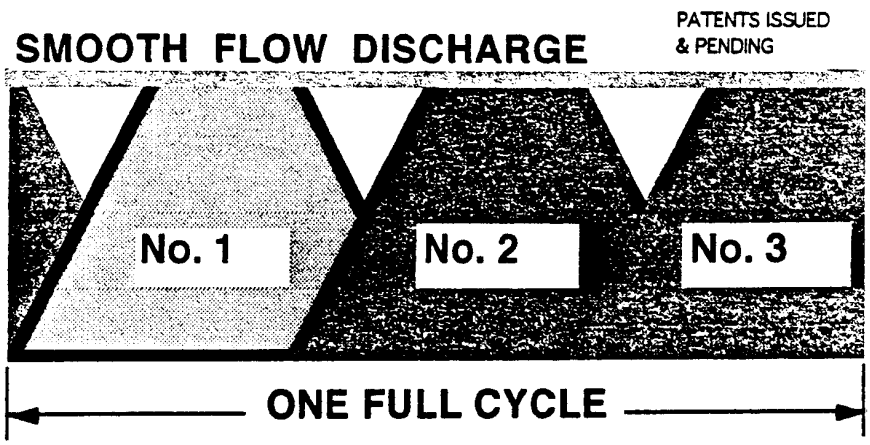


FIGURE 3 -- TRAPEZOIDAL PISTON FLOW PROFILE

To accomplish smooth flow, each of the three pumping pistons is driven in a proprietary trapezoidal flow profile. For non-shock flow, each piston is stopped momentarily (dwell) at the top and bottom of the stroke. This allows time for the energy recovery inlet and outlet valves to switch at zero flow rate. This assures that there is no hydraulic shock, allowing easy accomplishment of high flow rates for major facilities. Because both the feed and concentrate flow are controlled by the positive displacement cylinders, any variations in the membrane, supply, or discharge pressures will not affect the flow rate setting to and from the RO membrane banks. The VARI-RO method provides low maintenance cost through direct in-line energy transfer, low cycle speeds, and smooth (without pulsations or shock) flow for all the flow streams. These flow streams include: SUPPLY to the pumping pistons, FEED to the membrane bank, CONCENTRATE to energy recovery, and DISCHARGE to drain.

The energy cost savings result from:

a) pressure adaptive positive-displacement pumping and energy recovery,

b) highly efficient in-line forces to the feed flow from the concentrate and hydraulic flows,

c) cutting out "middleman" losses that result from intermediate equipment in competitive methods, such as: speed reduction belts, flow throttle valves, booster pumps, variable frequency drives, sump pumps, etc.

A further benefit of the VRO-IPER version is that it is accomplished at low cycle speeds as compared conventional crank type pumps (plunger). With plunger pumps, pressure pulsations and cycle speeds on the packing glands & valves result in high maintenance costs for the pumping equipment—and also for the piping and membrane system.

a

7. Inter-Stage Boost Option – VRO-ISB

For facility optimization, the VARI-RO high efficiency Inter-Stage Boost (VRO-ISB) option can be easily incorporated, as shown in **FIGURE 4**. This is accomplished by simply adding a highly-efficient second pumping piston to each water cylinder. This allows two stages of lower recovery ratio, say 35% each; but provides a high overall recovery ratio for the facility, say 55%. The benefits include: lower pressure for the first stage, more effective utilization of the membranes resulting in fewer membranes, and higher quality product water. The optimization capability is discussed further in **SECTION 9**, Specific Energy Consumption for the VRO-IPER Version.

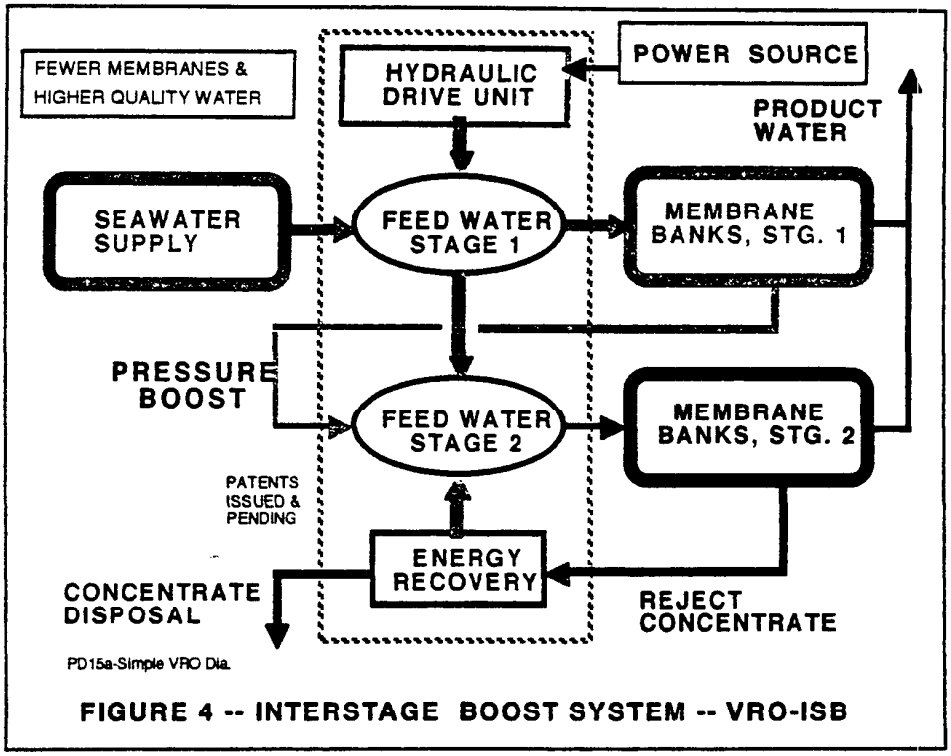


FIGURE 4 -- INTERSTAGE BOOST SYSTEM -- VRO-ISB

The VARI-RO Inter-Stage Boost (VRO-ISB) option provides a *"have your cake and eat it too"* solution. By using two stages, the first stage can operate at low recovery and also low pressure. The second stage can also operate at low recovery, but at a higher pressure due to the higher salinity of the feed water (higher osmotic pressure). Then by combining the product flow from the two stages, the overall recovery ratio for the facility is higher.

A further benefit may be possible by providing a way to inject anti-scaling chemicals only into the feed for the second stage—thus reducing the chemical cost and the environmental impact considerations for returning the reject concentrate to the sea.

8. VRO-IPER Energy Consumption Calculations

FIGURE 5 gives the equations that are used to calculate the energy consumption for the VRO-IPER modular product. Typical efficiency values for these calculations would be electric motor efficiency (eEM) = 95%, hydraulic pump efficiency (eHP) = 88%, and water displacement unit efficiency (eWDU) = 92%. The pressure parameters used for these calculations were: supply (pS) = 30 psi, membrane drop (dpM) = 64 psi, and concentrate discharge (pD) = 5 psi.

The water displacement efficiency (eWDU) includes the cylinder efficiencies of: feed = 97%, energy recovery = 96%, and hydraulic cylinder = 99%, which multiplied together give 92%.

$$kwINPUT = \frac{0.302\ (MGD)}{(RR)(eEM)(eHP)(eWDU)} \left[(pM - pS) - (1 - RR)(pM - dpM - pD) \right]$$

$$secVRO = \frac{0.024\ (kwINPUT)}{MGD} = kWh/kgal$$

MGD = million gallons per day
RR = Recovery Ratio
eEM = efficiency Electric Motor
eHP = efficiency Hydraulic Pumps
eWDU = efficiency Water Displacment Unit

pM = pressure, Membranes
pS = pressure, Supply = PSI
dpM = delta pressure, Membranes
pD = pressure, Discharge

FIGURE 5 -- CALCULATION EQUATIONS & PARAMETERS -- VRO-IPER

With these equations **[Ref. 2, Page 27]** it is quite easy to calculate the expected VRO-IPER specific energy consumption for a given RO desalination train. These results can then be compared to existing and/or new facilities using conventional methods.

9. Specific Energy Consumption for VRO-IPER Version

FIGURE 6 gives the typical specific energy consumption that the VRO-IPER version can achieve, based on the equations, efficiencies, and parameters given in **SECTION 8**. This figure gives the energy consumption for various membrane pressures (pM) for various recovery ratios (RR). It should be noted that at constant pressure, the energy consumption is relatively flat as compared to systems using centrifugal pumps, and lower efficiency energy recovery methods.

This feature is particularly important when considering the recovery ratio for the facility. For example, with the lower efficiency of centrifugal pumps and energy recovery turbines there is a tendency to go to the highest feasible recovery ratio to minimize the pre-treatment flow, and to get lower energy consumption—even at higher membrane pressure that results from higher osmotic pressure. However, under these conditions, the membranes are not effectively utilized. For example, the first membranes in the pressure vessel get high net driving pressure (excessive flux), and the last membranes get low net driving pressure (lower than rated flux).

With the energy penalty removed from lower recovery ratio operation, it is possible to either operate at lower pressures (lower energy consumption), or use fewer membrane elements (lower capital cost for the membranes). This is covered in more detail in the USBR Reports **[Ref. 1, Page 25 and Ref. 4, Page 32]**. For related discussion, see **SECTION 7**, Inter-Stage Boost – VRO-ISB. These various options provide the desalination professional additional capability to provide fresh water from the sea at the lowest possible cost.

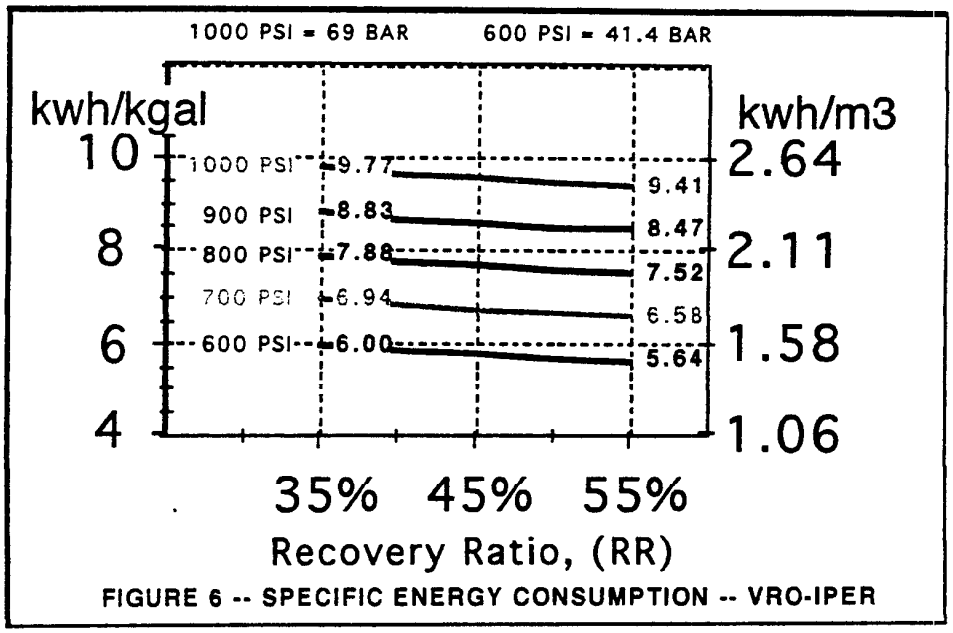


FIGURE 6 -- SPECIFIC ENERGY CONSUMPTION -- VRO-IPER

The metric energy recovery values (kwh/cubic meter) can be obtained by dividing the values given by 3.785. EXAMPLE: For a recovery ratio of 35% at 700 psi, the energy consumption given is 6.94 kwh/1000 US gallons, which is 1.83 kwh/m^3. This is less than 2.0 kwh/m^3 at this pressure.

10. Differentiation from Competitive Methods—VRO-IPER Version

The VARI-RO Integrated Pumping & Energy Recovery (electric powered) version is a revolutionary approach for seawater desalination. **Why is it revolutionary?**

Because this version provides the following features and benefits:

- Integrates both the pumping & energy recovery— Increases overall efficiency.
- Inter-Stage Boost or lower energy recovery can be used— higher quality product water.
- Modular units— minimizes customer interface and installation costs.
- Positive displacement— automatic adaptation to variable membrane / system pressures.
- Built-in recovery ratio control— no flow meters, boost pumps, bypass valves, or throttle valves.
- High energy-transfer efficiency— recovers over 90% of reject concentrate energy.
- Smooth flow (trapezoidal flow profile)— efficient positive displacement without pulsations.
- Energy recovery valves switch during zero flow rate dwell— no hydraulic shock.
- Low cycle speeds— high reliability, longevity, and low maintenance.

At 15 CPM (cycles per minute) it would take 20 years to get the same number of cycles that positive-displacement, crank-type, pump at 300 RPM would get in one year.

- No variable frequency drives or flow throttle valves— as with centrifugal pumps (CP).
- No high cycle speeds and pressure pulsations— as with crank type plunger pumps (PP).
- No pulsation dampeners— as with crank type plunger pumps (PP).
- No geometric side load forces— as with crank type plunger pumps (PP).
- No speed reduction belts— as with crank type plunger pumps (PP).
- No substantial mounting foundations— install the modular units anywhere in the facility.
- No sumps or sump pumping— as with Pelton wheels (PW).
- No hydraulic shock— as with work exchangers (WEER).
- No mixing of concentrate with the feed water— as with pressure exchangers (PX).
- No need for high-pressure flow meters and flow control— as with pressure exchangers (PX).
- No booster pumps— as with either work or pressure exchangers (WEER or PX).

11. Product Description — VRO-DDE Version

The technological innovation (patents issued and pending) of the "crank-less" VARI-RO Direct Drive Engine (VRO-DDE) is positive-displacement, pressure-to-pressure, energy transfer methods. Simply put, it is a high-efficiency, external-combustion, reciprocating engine that can lower the energy cost for SWRO desalination, and a variety of other applications. The efficiency improvement is a result of direct, in-line, transmission of forces. This will dramatically lower the energy cost of seawater reverse osmosis (SWRO) desalination pumping **[Ref. 4, Page 30]**, as compared to using electric power.

The analysis and evaluation sponsored by USBR **[Ref. 3, 4]** has shown that up to 70% energy cost savings for SWRO desalination is achievable, as compared to the predominant methods now in use today for large-scale SWRO.

The thermodynamic principles are the same as gas turbines, except that it is positive-displacement instead of turbo, and closed-loop instead of open-loop. This provides for higher efficiencies at lower combustion temperatures, and the capability to adapt easily to a wide range of operating load conditions. All of these factors result in lower emissions, and lower fuel cost for a given power output. The lower emissions (NOx and particulates) also result from continuous combustion as compared to intermittent (explosive) combustion of internal combustion engines (diesel or natural gas).

For major desalination facilities, electric motors are presently only considered acceptable in the USA. While internal combustion engines will provide better fuel to water economy, these are not presently considered because of high air pollution, special emissions control equipment, special fuel requirements, noise, and high maintenance requirements that result from high operating speeds.

The VARI-RO Direct Drive Engine (VRO-DDE) system combines the benefits of continuous combustion technology (similar to gas turbines) with the benefits of positive displacement (similar to Diesel engines), plus adds variable stroke capability (computer and hydraulic control); resulting in a thermal energy conversion system which can:
1) have low emissions (zero as a heat recovery or hydrogen burning engine),
2) be highly efficient, and
3) perform effectively over a wide range of operating conditions.

As shown in **FIGURE 7,** the working fluid (air or other gas) is compressed and enters the recuperator at T2, where it is heated to Tx and then to T3 in the heater. The hot gas enters the expander to do work, and the exhaust proceeds through the recuperator and cooler back to the compressor inlet. The expander provides force (back work) to drive the compressor. The remaining force results in reciprocating power output to directly drive double-acting compressor or pumping pistons. The usual case is three piston assemblies operating in complementary fashion, which are controlled by a unique hydraulic drive—instead of conventional cranks.

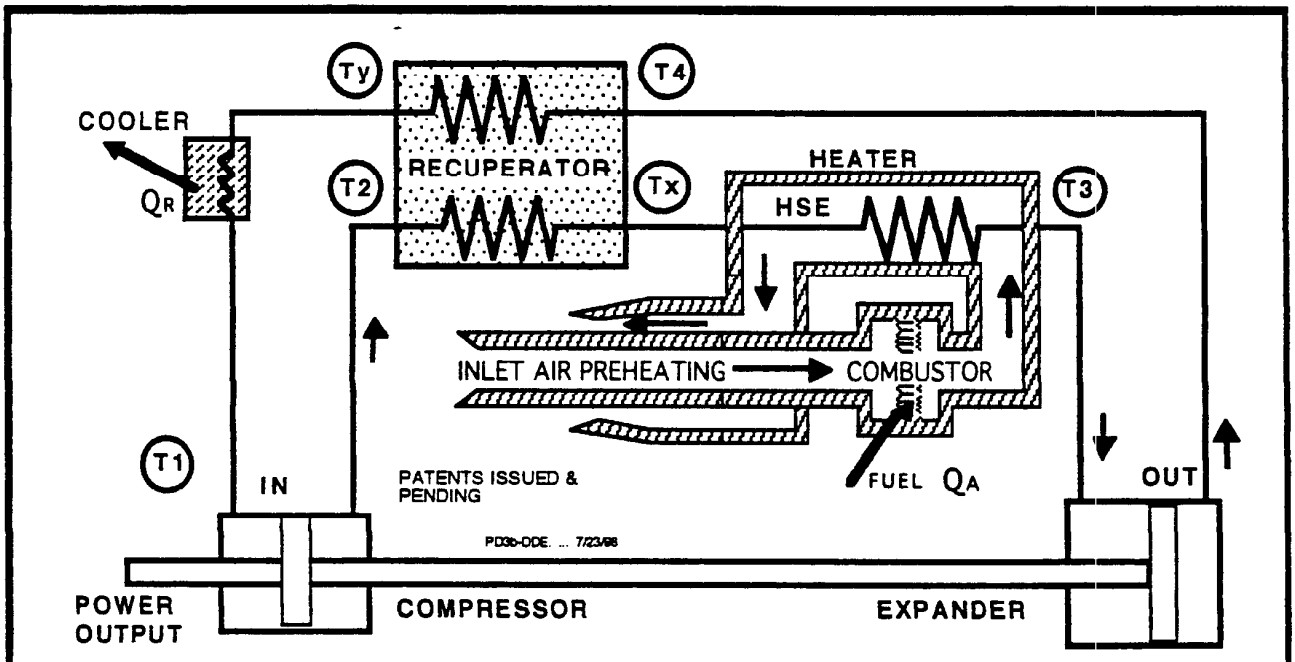


FIGURE 7 -- DIRECT DRIVE ENGINE -- VRO-DDE

The VRO-DDE innovation is made possible by the novel application of modern hydraulic power and computer control. The computer controls expander valve timing and synchronizes the hydraulic drive to provide smooth operation suitable to power the VRO-IPER version, which has been previously described.

The energy cost savings result from:

a) a lower cost energy source,

b) being highly efficient,

c) cutting out "middleman" losses.

A further benefit of the Direct Drive Engine version is that it is accomplished without the geometrically induced side loads of diesel engines. In conventional crank type engines, geometric side loads results in high maintenance costs due to piston to cylinder wear—along with high operating speeds. The VRO-DDE version provides for low maintenance cost through direct in-line energy transfer, low cycle speeds, and smooth output flow.

12. Differentiation from Competitive Methods—VRO-DDE Version

The VARI-RO Direct Drive Engine version directly uses fuel to provide power to the VRO-IPER version, providing a further revolutionary approach for seawater desalination. **Why is this approach revolutionary?**

Because it provides the following features and benefits, as compared to conventional engines:

- Can be used instead of electric motors— lower cost energy source.
- Directly drives the reciprocating VRO-IPER version— cuts out "middleman" losses.
- Use any thermal energy source— natural gas, fuel oil, gas turbine exhaust, solar, geothermal.
- Low emissions due to continuous combustion— as compared to diesel engines.
- Low noise levels and vibrations— as compared to diesel engines.
- Low cycle speeds— high reliability, longevity, and low maintenance.

> At 15 CPM (cycles per minute) it would take 100 years to get the same number of cycles that positive-displacement, crank-type, engine at 1500 RPM would get in one year.

- No geometric side load forces— as with diesel engines.
- No crankcase lubricants (with combustion products) to change— as with diesel engines.
- No substantial mounting foundations— install the modular units anywhere in the facility.

13. Conclusions and Future Plans

The testing and evaluation accomplished through cost-share funding provided by the U. S. Bureau of Reclamation and a broad coalition of public and private organizations has shown that the VARI-RO technologies have breakthrough potential. As covered in **SECTION 2**, the VRO-IPER pilot plant unit was thoroughly tested and evaluated by representatives from the Navy's Seawater Desalination Laboratory. In addition, the VRO-DDE version was thoroughly analyzed by experts in the field, and a proof-of-function engine was evaluated.

With these technologies, the energy consumption can be dramatically reduced for large-scale SWRO facilities as shown in **FIGURE 1**. In addition substantial operational benefits can be provided as stated in **SECTION 10** and **SECTION 12,** as compared to competitive methods.

We are seeking public and private participants, strategic partners, licensees, and investors for demonstration, business development, and commercialization of these needed technologies.

The primary need now is to proceed with a demonstration project, which can be done in two phases—first the VRO-IPER unit and then the VRO-DDE unit. This project would be to identify a suitable demonstration site, then design, build, install, and operate a VRO-IPER unit. Parallel to this effort, proceed with the VRO-DDE system, which would be retrofitted to the previously installed VRO-IPER unit.

The goal is to proceed with an accelerated program to demonstrate these technology advancements. With an accelerated program, the technology can be proven in time to be used for the major seawater desalination facilities that are now being planned and implemented in California, Florida, and Texas --- plus other facilities around the world. The energy cost savings will help assure that these projects go forward—providing needed water supplies and growth in the desalination industry.

14. References

1. Childs, Willard D., Ali E. Dabiri, Ph.D. (1995); ***"VARI-RO™ "Low Energy" Desalting for the San Diego Region",*** (the VARI-RO study), Final Technical Report, WTTP Report **No. 4**, U. S. Bureau of Reclamation, June 1995.
2. Childs, Willard D., Ali E. Dabiri, Ph.D. (1998); ***"VARI-RO™ Desalting Pilot Plant Testing and Evaluation",*** Final Technical Report, WTTP Report **No. 30**, U. S. Bureau of Reclamation, May 1998.
3. Childs, Willard D., Ali E. Dabiri, Ph.D. (1998); ***"VARI-RO™ Direct Drive Engine Study"***, Final Technical Report, WTTP Report **No. 33**, U. S. Bureau of Reclamation, September 1998.
4. Childs, Willard D., Ali E. Dabiri, Ph.D. (2001); ***"VARI-RO™ Desalting Pilot Plant Advancement Project, Testing and Evaluation"***, Final Technical Report, DesalR&D Report **No. 62**, U. S. Bureau of Reclamation, May 2001. NOTE: The confidential appendices are available directly from the author with a suitable confidentiality agreement.

VARI-RO USBR reports available at: **http://www.usbr.gov/water/content/c_reports.html** (pdf format). Also, the appendices listed in Report No. 62 are available directly from Willard Childs, VPC.

Response No. 21

Vari-Power Company
Willard Childs

21a. This letter is composed of marketing information for seawater desalination technology, and does not contain comments on the Draft EIR. No response is required.

3.0 ERRATA TO DRAFT EIR TEXT

Changes to the EIR are noted below. Additions to the text are indicated with shading. Deletions to the text are indicated with stricken text. Changes have been analyzed and responded to in Section 2.0, Responses to Comments. The changes to the EIR do not affect the overall conclusions of the environmental document. Changes are listed by page and where appropriate by paragraph.

NOTE TO REVIEWER:

This Errata has been prepared in response to comments received on the Draft EIR, which was available for public review from September 19, 2002, to November 4, 2002. Additional editorial corrections have been initiated by City staff. These clarifications and modifications are not considered to result in any new or greater impacts than identified in the Draft EIR. To avoid redundancy, it should be assumed that additions, modifications, or deletions of text within Sections 4.1 through 4.9 of the Draft EIR, when applicable, are reflected in Section 1.0, *EXECUTIVE SUMMARY.*

Page 3-1, ENVIRONMENTAL SETTING

".....and would not require modifications to the coastal/marine portions of the existing AES ocean intake/discharge facilities. However, it should be noted that the existing AES intake/discharge facilities are owned by the California State Lands Commission (CSLC), and are leased to AES. A lease agreement between the CSLC, AES, and the project applicant will be required prior to project approval."

Page 3-9, Proposed Buildings and Structures

"All proposed buildings and structures will comply with state and local standards in regards to fire and structural safety. The proposed desalination project would consist of the following buildings and structures:

Administration Building (approximately 158'L x 57'W x 15'H, 9,900 s.f.): This building is proposed to be Type-II, non-rated (generally defined by the California Building Code as structures incorporating non-combustible materials [steel, iron, concrete, or masonry] for structural elements, floors, walls, and roofs) and will be constructed of steel. The exterior will feature flat metal wall panels running vertically along the face of the structure. A metal panel roof system will be screened with a metal fascia using deep-ribbed metal panels running horizontally. All glazing will be tinted and will include clear anodized window frames."

Page 3-11, Proposed Desalination Plant Flow Process

".....An intake pump station will be located near the pre-treatment filters of the proposed plant to lift the water out of the intake pipeline and into the RO pre-treatment facilities (refer to Exhibit 6, *DESALINATION PROCESS FLOW SCHEMATIC*). The proposed plant would divert approximately 100 mgd of water from the AES condenser cooling water system. It should be noted that the proposed project would utilize pumps circulating a total of 126 mgd. These pumps would operate constantly and would be independent of the AES Generating Station. Should the AES facility cease to operate, the proposed desalination facility would continue produce and distribute potable water. To prevent growth of marine organisms in the intake system, chlorination....."

Page 3-20, OFF-SITE IMPROVEMENTS

".....potential water compatibility impacts that may result from introduction of desalinated seawater into the regional water system).

Edison Avenue Improvements

As a condition of approval by the City of Huntington Beach for the proposed project, the applicant will be required to complete half-width improvements along the southern side of Edison Avenue (situated north of the subject site as shown in Exhibit 2 of the Draft EIR, *SITE VICINITY MAP*). These half-width improvements would consist of the dedication of 30 feet along the frontage of the existing Edison Avenue (22 feet for paved street widening and eight feet for landscaped parkway) for a total of approximately 800 linear feet. It should be noted that AES Huntington Beach, LLC would be responsible for dedication of property to the City for these improvements, as AES owns the entire southern frontage of Edison Avenue and would lease property to the applicant for the proposed project. However, the project applicant would be responsible for completing these roadway and landscaping improvements as a condition of approval for the project subsequent to property dedication. It should also be noted that street widening along Newland Street (west of the proposed project site) would be performed by the City, with separate entitlements and environmental evaluation. AES Huntington Beach, LLC would dedicate the necessary right-of-way along Newland Street and both AES and the project applicant would be required to pay their fair share of the cost.

Page 3-20, PROJECT NEED AND OBJECTIVES

".....Although the region has made a significant financial investment in the imported water system and the system has met all of the region's supplemental water supply needs ~~(except in times of extreme drought~~ with the exception of a one year period from March 1991 to March 1992), there is a present concern regarding the amount of water....."

Page 3-21, PROJECT NEED AND OBJECTIVES

".....Solutions to potential water shortage and reliability problems include water management programs on imported water systems as well as an increased reliance on many different sources of water supply and a continued emphasis on water conservation through implementation of State-approved Best Management Practices (BMP's). Orange County has implemented several successful programs including ultra low flow toilet and low flow shower head programs, conservation based rate structure programs, landscape conservation programs and commercial, industrial and institutional conservation programs. However, according to the Orange County Water District Master Plan Report (Section 5.6.2), potential conservation savings will be limited to no more than 30,000 to 60,000 acre feet per year. This amount is hardly sufficient to offset ~~potential losses in imported supplies~~ anticipated water shortages due to increases in population and economic activity.

Water recycling (reclamation of wastewater to produce water that is safe and acceptable for various non-potable uses, but not approved for drinking and other domestic uses) is a technology that has provided a valuable source of water supply for Southern California. Southern California (and Orange County in particular) leads the way in producing recycled water to offset potable water demands. In 1996 the major imported water supplier in the region, MWD, adopted its so-called "Southern California's Integrated Water Resources Plan" (IRP) representing a dramatic shift in water management and resource planning for the region. The IRP identified 80 different local recycling projects producing over 150,000 acre feet per year of water supply available to the region. Depending upon technological advancements and

economic constraints, the IRP projected that as much as 800,000 acre feet of recycled water could be made available to the region by 2020. Recycled water projects will certainly be relied upon to ~~replace the future reductions in imported water supplies and to~~ meet the demands of projected growth in the region. However, recycled water has not been approved for drinking or for other potable uses.

Desalinated seawater can be made directly available for drinking and other potable uses. Consequently, seawater desalination was also one of several ~~integrated sources of supply~~ potential resource options identified in the IRP. The IRP also recommended that groundwater recovery projects, storage projects, water recycling projects, water transfer projects and water conservation projects be included in the "resource mix". The IRP ~~predicts~~ states that, ~~"about 200,000 acre-feet per year (of desalinated ocean water) could be developed by 2010"~~ based on feasibility studies on potential projects, about 200,000 acre-feet per year (of desalinated ocean water) could be developed by 2010 (p. 3-12). The proposed Poseidon Seawater Desalination Project represents an opportunity to develop approximately 56,000 acre-feet per year, or approximately one fourth of ~~that project supply need~~ the potential for seawater desalination development identified by the 1996 IRP."

Page 3-22, PROJECT NEED AND OBJECTIVES

".....and environmental impacts to biological resources. In general, anticipated statewide shortages can be expected to translate to equivalent local and regional shortages, with similar

economic and environmental effects. Senate Bill (SB) 221 and SB 610 require demonstration of water supply reliability prior to development."

Page 3-25, AGREEMENTS, PERMITS, AND APPROVALS REQUIRED

".....The following agreements, permits, and approvals are anticipated to be necessary:

Approval/Permit, Permits to Operate	Agency
Final EIR Certification	City of Huntington Beach
Conditional Use Permit	City of Huntington Beach
Coastal Development Permit[1]	City of Huntington Beach
Franchise Agreement	City of Huntington Beach
~~Drinking~~ Domestic Water Supply Permit	State of California Department of Health Services
Coastal Development Permit[2]	California Coastal Commission (CCC)
NPDES Permit	Santa Ana Regional Water Quality Control Board
Permit to Operate	South Coast Air Quality Management District
Encroachment Permits	U.S. Army Corps of Engineers (Santa Ana River Crossing)
	Caltrans, District 12 (SR-55 undercrossing)
	County of Orange (channel crossings, pump station)
	City of Huntington Beach (product water pipeline)
	City of Costa Mesa (product water pipeline)

[1] The City's Coastal Development Permit approval may be appealed to the California Coastal Commission.

[2] A CDP is required directly from the CCC for the ocean discharge.

	Mesa Consolidated Water District (product water pipeline)
	Metropolitan Water District of Southern California (product water pipeline)
Institutional Agreements	Various cities, agencies, and regional water purveyors.
Lease Agreement	California State Lands Commission
Industrial Source Control Permit	Orange County Sanitation District"

Page 4.1-10, RELEVANT PLANNING

".....As such, the proposed desalination facility's ocean discharge will require separate review and approval by the California Coastal Commission of a Coastal Development Permit.

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS (SCAG) REGIONAL COMPREHENSIVE PLAN AND GUIDE

Growth Management Chapter

- 3.03: The timing, financing, and location of public facilities, utility systems, and transportation systems shall be used by SCAG to implement the region's growth policies.
- 3.18: Encourage planned development in locations least likely to cause adverse environmental impacts.
- 3.21: Encourage the implementation of measures aimed at the preservation and protection of recorded and unrecorded cultural resources and archaeological sites.
- 3.22: Discourage development, or encourage the use of special design requirements, in areas with steep slopes, high fire, flood, and seismic hazards.
- 3.23: Encourage mitigation measures that reduce noise in certain locations, measures aimed at preservation of biological and ecological resources, measures that would reduce exposure to seismic hazards, minimize earthquake damage, and to develop emergency response and recovery plans.

Air Quality Chapter

- 5.11: Through the environmental document review process, ensure that plans at all levels of government (regional, air basin, county, subregional, and local) consider air quality, land use, transportation, and economic relationships to ensure consistency and minimize conflicts."

Page 4.1-11, RELEVANT PLANNING

"The project evaluated within this EIR proposes to implement a 50 mgd desalination plant within an industrial area. Project implementation would be consistent with the City of Huntington Beach General Plan, Local Coastal Program, ~~and~~ Zoning and Subdivision Ordinance, and SCAG Regional Comprehensive Plan and Guide (RCPG). During the "design development" stage, the Applicant....."

Page 4.3-11, Impacts on Source Water from the OCSD Outfall

".....The OCSD discharges up to 480 mgd of wastewater that has received primary treatment and some secondary treatment at an outfall that is located approximately fivemiles offshore at a depth of 195 feet. It should be noted that OCSD has committed to provide secondary treatment for 100 percent of all effluent it receives. The development of facilities to provide this additional secondary treatment could take up to 11 years to plan, design, construct, and commission. A more detailed implementation plan is being developed by the District and will be completed in early 2003.

In addition, on August 12, 2002, the OCSD began disinfecting its wastewater per Regional Water Quality Control Board (RWQCB) requirements. The OCSD is presently adding bleach as a disinfectant followed by sodium bisulfite to remove residual prior to ocean discharge, and will continue to do so for the next three to five years. Testing and studies are underway to evaluate other disinfection technologies, including ultraviolet light, ozone, and peracetic acid for long-term application.

The OCSD wastewater discharge would have the greatest potential to impact water quality at the AES intake with summer El Nino conditions when currents are flowing northwest towards the AES facility. In addition, for "worst case" conditions, the model assumed that OCSD was discharging at its maximum allowable rate of 480 mgd and that the temperature conditions in the ocean would allow the wastewater plume to be near the depth of the AES intake.

The model showed that under these extreme conditions, the OCSD discharge would be diluted 10 million to one at the AES intake and would not affect water quality at the intake. This dilution would be further increased in consideration of OCSD's proposed secondary treatment process and current disinfection process, which were not accounted for within modeling in this Draft EIR. Impacts in this regard are anticipated to be less than significant."

Page 4.3-19, Water Quality Impacts to Marine Biological Resources

The "first flush" treated waste cleaning solution from the washwater tank will be discharged into the local sanitary sewer for further treatment at the Orange County Sanitation District (OCSD) regional wastewater treatment facility. The cleaning flush water following the "first flush" will be mixed with the RO plant brine concentrate, treated waste filter backwash, and the AES plant discharge and sent to the ocean. This "second flush" water stream will contain trace amounts of cleaning compounds and would be below detection limits for hazardous waste. An Industrial Source Control Permit from the OCSD for discharge of waste cleaning solution into the sanitary sewer system will be required for the project. In addition, the discharge must comply with the limits and requirements contained in the OCSD's Wastewater Discharge Regulations. Impacts to the local marine environment in this regard would be less than significant.

Page 4.6-3, Roadway Maintenance

"The City of Huntington Beach Public Works Department provides roadway maintenance to the City of Huntington Beach. The Department performs regular maintenance on City owned roadways in the form of re-paving, pothole/curb repairs, and striping, as well as roadway widenings, expansions, and improvements. It should be noted that the City of Huntington Beach Public Works Department has ~~recently conditioned Newland Street (located west of the subject site) to be improved as a result of ongoing renovations to the AES Huntington Beach Generating Station. In addition, should the underground or the aboveground "North" product water storage tank option be selected, Edison Avenue, located north of the project site, will need to be improved with curb, gutter, sidewalk, street lighting, and paving~~ conditioned the

widening of both Newland Street (located west of the subject site) and Edison Avenue (situated north of the subject site). The applicant would be required to complete half-width improvements along the southern side of Edison Avenue as a condition of approval for the project, while the City would be responsible for improvements along Newland Street with the applicant paying their fair share. For more information refer to the "Impacts" section below."

Page 4.6-4, Storm Water Drainage

".....The OCFCD and the City of Huntington Beach Public Works Department operate the storm water drainage system within the City of Huntington Beach. The storm drainage system removes water runoff from streets, and~~, after filtration~~, transports the runoff to the ocean. The OCFCD owns, operates, maintains, and improves regional flood control facilities. The City of Huntington Beach owns and operates 145 storm drainage channel pumping stations which pump the runoff water into the channels and to the ocean. No runoff from the project site....."

Page 4.6-5, Reclaimed Water

".....The City of Huntington Beach ~~is currently participating~~ participated in the Green Acres project (GAP) in association with the OCSD and the Orange County Water District (OCWD). The OCSD produces secondary treated water for the OCWD, where the water is treated once again and distributed for potential industrial use and landscape irrigation ~~in~~ for the Cities of Fountain Valley, Santa Ana, Costa Mesa, Newport Beach, and Huntington Beach. ~~In addition, the City of Huntington Beach also plans to implement the Groundwater Replenishment System (GWRS).~~ The GWRS is a major ~~new~~ reclamation project currently being developed by the OCSD and OCWD. This project could increase the City's use of reclaimed water to 400 afy. At the present time, no conveyance facilities are available at or near the subject site, and it is not anticipated that the proposed desalination project will require the use of reclaimed water."

Page 4.6-8, Roadway Maintenance

"As previously stated, both Newland Street and Edison Avenue have ~~has recently~~ been conditioned to be improved~~, and, should the underground or aboveground "North" product water storage tank option be selected, Edison Avenue will require curb, gutter, sidewalk, street lighting, and paving improvements.~~ by the City of Huntington Beach Department of Public Works. As a condition of approval by the City of Huntington Beach for the proposed project, the applicant will be required to complete half-width improvements along the southern side of Edison Avenue (situated north of the subject site as shown in Exhibit 2 of the Draft EIR, *SITE VICINITY MAP*). These half-width improvements would consist of the dedication of 30 feet along the frontage of the existing Edison Avenue (22 feet for paved street widening and eight feet for landscaped parkway) for a total of approximately 800 linear feet. It should be noted that AES Huntington Beach, LLC would be responsible for dedication of property to the City for these improvements, as AES owns the entire southern frontage of Edison Avenue and would lease property to the applicant for the proposed project. However, the project applicant would be responsible for completing these roadway and landscaping improvements as a condition of approval for the project subsequent to property dedication. It should also be noted that street widening along Newland Street (west of the proposed project site) would be performed by the City, with separate entitlements and environmental evaluation. AES Huntington Beach, LLC would dedicate the necessary right-of-way along Newland Street and both AES and the project applicant would be required to pay their fair share of the cost. In addition,traffic impact fees as determined by the City of Huntington Beach will be collected upon project implementation in

order to offset any costs incurred for roadway widenings and intersection capacity improvements.[3] Impacts in this regard are anticipated to be less than significant.

Page 4.6-9, Wastewater

".....eight-inch sewer conveyance pipeline leading off-site to the existing 48-inch OCSD sewer pipeline located within Newland Avenue or a 54-inch OCSD line within Pacific Coast Highway. OCSD has also indicated that the pH and flowrate of the washwater tank discharge would be acceptable, contingent upon the acquisition of a Sewer Connection Permit from the City of Huntington Beach and an Industrial ~~Waste Discharge~~ Source Control Permit from the OCSD. It should be noted that the County of Orange's....."

Page 4.6-17, Hydraulics

".....However, the hydraulic characteristics of the OC-44 Pipeline may be affected in one of two ways, depending on whether the pipeline segment in question is east or west of the proposed Poseidon/OC-44 connection point. West of the proposed Poseidon/OC-44 connection point, the flow rate and flow direction would remain unchanged, while a change in water pressure would be negligible (a change of less than five pounds per square inch). East of the proposed connection point, the direction of flow would be reversed, the flow rate would increase, and water pressure would decrease. It is anticipated that maximum flow velocity through this portion of the pipeline would be 7.5 feet per second (fps). All flow rate, pressure, and velocity changes which may occur in the existing pipelines are within pipeline design specifications. It should be noted that the OC-44 connection is operated by a Joint Powers Authority (with Mesa Consolidated Water District as the approving agency). The applicant will obtain appropriate approvals from the Mesa Consolidated Water District prior to project operation in order to ensure that impacts to the OC-44 do not adversely impact the Joint Powers Authority. In addition, the proposed project would not inhibit the City of Huntington Beach's ability to operate the OC-44 from zero to 13 cubic feet per second (CFS) without restriction or need for notification."

Page 4.6-18, Reclaimed Water

"The City of Huntington Beach is not currently ~~utilizes~~ utilizing ~~limited amounts of~~ reclaimed water, although the City ~~is planning to expand its use of reclaimed water~~ may in the future through the Green Acres Project and Groundwater Replenishment System. The proposed project is not anticipated to require the use of reclaimed water or installation of reclaimed water facilities, as the project itself will be a new reclamation source. Impacts in this regard are not anticipated to be significant.

Page 4.6-21, MITIGATION MEASURES

"PSU-1 Prior to the issuance of building permits, ~~the Applicant will be required to pay a commercial fee of $0.1287 per square foot for non-residential development~~ the applicant will be required to pay applicable mitigation fees pursuant to State law."

[3]Letter, Mr. Todd Broussard, City of Huntington Beach Public Works Department, July 16, 2001.

Page 4.9-19, BIOLOGICAL RESOURCES

".....not anticipated to be significant (refer to Appendix L, *BOOSTER PUMP STATION BIOLOGICAL CONSTRAINTS* SURVEY, for additional information). It should also be noted that any displaced vegetation would be replaced.

In addition, implementation of the proposed project may result in impacts to waterways due to "frac-outs" potentially occurring during pipeline construction. "Frac-outs" occur when drilling fluids (usually bentonite) seep to the surface via cracks in the ground. Prior to the performance of any directional boring, the applicant will prepare a Frac-Out Contingency Plan. The plan will establish criteria under which a bore would be shut down (e.g., loss of pressure, loss of a certain amount of returns) and the number of times a single bore should be allowed to frac-out before the bore is shut down and reevaluated. It will also clearly state what measures will be taken to seal previous frac-outs that have occurred on a given bore to ensure that it does not become the path of least resistance for subsequent frac-outs. Additionally, the site-specific Frac-Out Contingency Plan will be prepared and reviewed by the City Engineer and appropriate resource agencies prior to each major bore."

Page 4.9-28, MITIGATION MEASURES

".....of the roadway using appropriate construction signage and flagmen, or submit a detour plan for approval by the City Traffic Engineer.

- The Traffic Management Plan shall be approved by affected agencies at least two weeks prior to construction. Per Caltrans requirements, the applicant shall submit the Traffic Management Plan to Caltrans at the 90-percent design phase;"

Page 4.9-30, MITIGATION MEASURES

".....restrictions on construction activities may be required in the vicinity of the nest until the nest is no longer active.

CON-40 Prior to the commencement of any directional boring for water conveyance pipeline implementation, the applicant shall prepare a Frac-Out Contingency Plan. The plan shall establish criteria under which a bore would be shut down (e.g., loss of pressure, loss of a certain amount of returns) and the number of times a single bore should be allowed to frac-out before the bore is shut down and reevaluated. It will also clearly state what measures will be taken to seal previous frac-outs that have occurred on a given bore to ensure that it does not become the path of least resistance for subsequent frac-outs. Additionally, the site-specific Frac-Out Contingency Plan will be prepared and reviewed by the City Engineer and appropriate resource agencies prior to each major bore.

CON-41 In order to minimize potential construction impacts to nesting savannah sparrows adjacent to the proposed desalination facility, a pre-construction nesting survey will be performed by a qualified biologist in consultation with applicable regulatory agencies. Should nesting savannah sparrows be found, adequate mitigation (such as relocation, construction noise abatement measures, etc.) will be implemented as appropriate based on the findings of the pre-construction survey.

CON-42 All focused surveys for sensitive biological resources performed prior to proposed project implementation shall include a review of data within the California Natural Diversity Data Base (CNDDB) to obtain current information on any previously reported sensitive species/habitat, including Significant Natural Areas identified under Chapter 12 of the Fish and Game Code.

CON-43 Prior to implementation of the proposed off-site booster pump station adjacent to the NCCP/HCP boundary, a jurisdictional delineation of the proposed pump station site shall be performed to determine the extent of jurisdictional area, if any, as part of the regulatory permitting process.

CULTURAL RESOURCES

CON-~~404~~ Should buried historical/archaeological resources be discovered during excavation on the proposed booster pump station site, all construction work in that area shall be halted or diverted until a qualified archaeologist can evaluate the nature and significance of the finds.

CON-~~415~~ During excavation of five feet below ground surface or lower on the proposed booster pump station site, a paleontological resource recovery program for Miocene invertebrate fossils shall be implemented. This program shall include, but will not be limited to, the following:

- Monitoring of excavation in areas identified as likely to contain paleontologic resources by a qualified paleontologic monitor. The monitor shall be equipped to salvage fossils as they are unearthed to avoid construction delays and to remove samples of sediments which are likely to contain the remains of small fossil invertebrates and vertebrates. The monitor must me empowered to temporarily halt or divert equipment to allow removal of abundant or large specimens. Monitoring may be reduced if the potentially fossiliferous units described herein are not encountered, or upon exposure are determined following examination by qualified paleontologic personnel to have low potential to contain fossil resources;
- Preparation of recovered specimens to a point of identification and permanent preservation, including washing of sediments to recover small invertebrates and vertebrates;
- Identification and curation of specimens into a museum repository with permanent retrievable storage. The paleontologist should have a written respository agreement in hand prior to the initiation of mitigation activities; and
- Preparation of a report of findings with appended itemized inventory of specimens. The report and inventory, when submitted to the appropriate Lead Agency, would signify completion of the program to mitigate impacts to paleontologic resources."

Page 5-7, Geographic Scope of Cumulative Impact Assessment

".....As discussed in Section 5.2, *GROWTH INDUCING IMPACTS*, the project may facilitate new development in ~~south~~ Orange County and the South Coast Region."

Appendix E, Watershed Sanitary Survey, Page E-41, Wastewater Collection, Treatment, and Discharges

Refer to Responses 17b and 17c of the Responses to Comments, above.